SECTION 19: INTEGRATION OF BUILDING SYSTEMS

19.1 General. This section provides guidance for the use of Integration of Building Systems (IBS) concepts for the design of all medical and medical research facilities. IBS design involves the coordinated design of all elements of a building, integrating the functional, architectural, electrical, energy, fire protection, mechanical, structural, and other features into a unified whole. All design elements are recognized as essential to a successful facility, and are therefore to be treated simultaneously and with equal weight. The objective of IBS design is to achieve a building of optimum functionality, appearance, maintainability and adaptability. Attention must be given to structure, utility systems and equipment with the involvement of all design disciplines from the beginning of design in order to minimize interference with the facility mission and at the same time assure high quality utility services. Inherent in IBS design for medical and medical research facilities is the minimization of maintenance traffic and operations within functional areas through careful consideration of equipment room locations and the routing of utility services. Equally important is the assurance of proper installation, and maintainability, of primary and distribution equipment through careful consideration and coordination of envelope space requirements. Utility system space planning must occur simultaneously with overall site and facility planning. Aesthetic prominence or idealized functional planning without full coordination with structure and all utility systems is not acceptable.

19.2 Policy. The basic IBS design concepts apply to all medical and medical research facilities regardless of size. The more sophisticated IBS Systems Module design concepts, including utility pods and interstitial walk-on decks dedicated to utility distribution, are to be considered only for larger or more complex facilities. Use of the IBS Systems Module design concepts must be approved by TMA-DMFO.

19.3 Basic IBS Design Concepts.

19.3.1 Equipment Room Locations. In planning the locations of mechanical, electrical and communications equipment rooms, designers shall consider such factors as exterior access, the routing path and length of service feeders to the areas served, and the proximity of ventilation air intakes to potential contamination sources. Well distributed equipment rooms minimize problems in design, construction and maintenance. Coordinate all equipment room locations to minimize utility distribution "choke points," particularly in above-ceiling spaces, where multiple systems may cross or converge. Such crossings lead to inadequate space for equipment installation, maintenance and ventilation. Major equipment rooms shall have exterior access with paved surfaces for wheeled transport of equipment. Consider also requirements for horizontal and vertical access to interior, below-grade or upper level equipment rooms including transport of the largest items of equipment that may require replacement.

19.3.2 Equipment Room Space Requirements. The designers shall assure that equipment space requirements are properly coordinated among the different design disciplines thus permitting proper installation while preserving required maintenance clearances. As equipment is normally competitively bid, the designers must assure that space envelope requirements are provided based on worst-case analyses of equipment from a minimum of three manufacturers. Plan and elevation views showing coordinated equipment and space envelopes shall be included in the required design submissions.

19.3.3 Utility Distribution Considerations. The length and complexity of utility distribution runs should be reasonably minimized to avoid unnecessarily high flow resistance with resulting additional energy consumption, larger duct and feeder sizes, and loss of future flexibility. When practicable, avoid routing utility feeders through areas they do not serve in order to minimize the impact and complexity of future facility modifications. Service isolation and balancing devices, and terminal equipment, that may require periodic inspection or maintenance should be located above corridors.

19.3.4 Distribution and Terminal Equipment Space Requirements. The designers shall assure that distribution and terminal equipment can be installed in the spaces indicated, including above-ceiling spaces, distribution spaces, chases, etc. This requires thorough coordination of all equipment with the architectural and structural features of the building. To assure that installation is possible, the designers shall plan distribution space requirements on the basis of sizing calculations and the worst-case joining, reinforcement and support conditions permitted by the design. The designers are particularly cautioned to carefully consider the vertical space requirements of sloped gravity piping services. The designers must also be aware of, and provide for, code-mandated dedicated space requirements above, and adjacent to, electrical panels and equipment.

19.4 IBS Systems Module Design Concepts. IBS Systems Module design concepts, as discussed below, are normally only economically practicable for larger or more complex facilities. Systems Module design locates the majority of utility distribution and terminal equipment on interstitial walk-on decks, thus permitting convenient installation and maintenance. A candidate project for Systems Module design shall be evaluated during initial design by an economic comparison with conventional design. All costs associated with acquisition, operation, maintenance and alteration for a period of 25 years, or the designated life of the proposed building, shall be included in the comparison.

19.4.1 Systems Module. The Systems Module, a designated unit of space one story in height, is the basic building block of a Systems Module building, i.e., the building is composed of separately identifiable Systems Modules each consisting of a utility pod, a distribution zone, a connection zone and an occupied zone. Each Systems Module is served by its own utility distribution systems. The relationship of the various zones is illustrated in Figures 19-1 and 19-2. Systems Modules should range in area from 930 to 2090 m^2 (10,000 to 22,500 ft^2). Although there is a spatial discipline associated with the Systems Module, the overall organization and massing of a building can be varied according to specific project requirements. Repetitive Systems Modules will allow both expanded forms to accommodate the need for a day-lighting/solar approach or compact forms to allow a closed approach that attempts to negate the effect of climate. These forms are illustrated in Figure 19-3. In multistory buildings the utility pods shall be stacked from floor to floor so that plumbing and electrical risers can be efficiently and economically accommodated.

19.4.1.1 Utility Pod. The utility pod contains air handling unit(s) and associated risers, fans, pumps, etc.; electrical and communications equipment and associated risers; and other main equipment and risers serving the Systems Module. Fresh air and exhaust openings are generally part of the utility pod enclosure. Access to the utility pod is from adjacent stairs. The utility pod is defined by the floor and the underside of the floor or roof structure above.

19.4.1.2 Distribution Zone. The distribution zone accommodates the main horizontal utility distribution systems of a Systems Module and provides convenient access to these systems by means of a suspended walk-on deck. Utility distribution systems enter and leave the utility pod through the distribution zone. The distribution zone consists of horizontal layers of space, or sub-zones, individually dedicated to specific utility distribution equipment (pipes, ducts, raceways, conduit, cable trays, etc.). This equipment is run in distribution channels within the sub-zones. Structural suspension members for the walk-on deck should be placed to define the distribution channels. Except for gravity piping services, most systems in the distribution zone down feed to the connection zone below. Access aisles are provided on the walk-on deck for maintenance access to equipment and at the perimeter of the walk-on deck. These shall provide sufficient clearance, exclusive of major structural members, for a worker to stand. Access aisles should have clearly marked dust-free walking surfaces. Any fireproofing of structural members crossing the access aisles should be covered or otherwise protected. Access to the distribution zone shall be from adjacent stairs and also, in multistory buildings, from key-operated service elevators designed to stop at the walk-on deck levels. No access to the distribution zone shall be permitted through access panels from the connection zone. The distribution zone is defined by the walk-on deck and the underside of the floor or roof structure above.

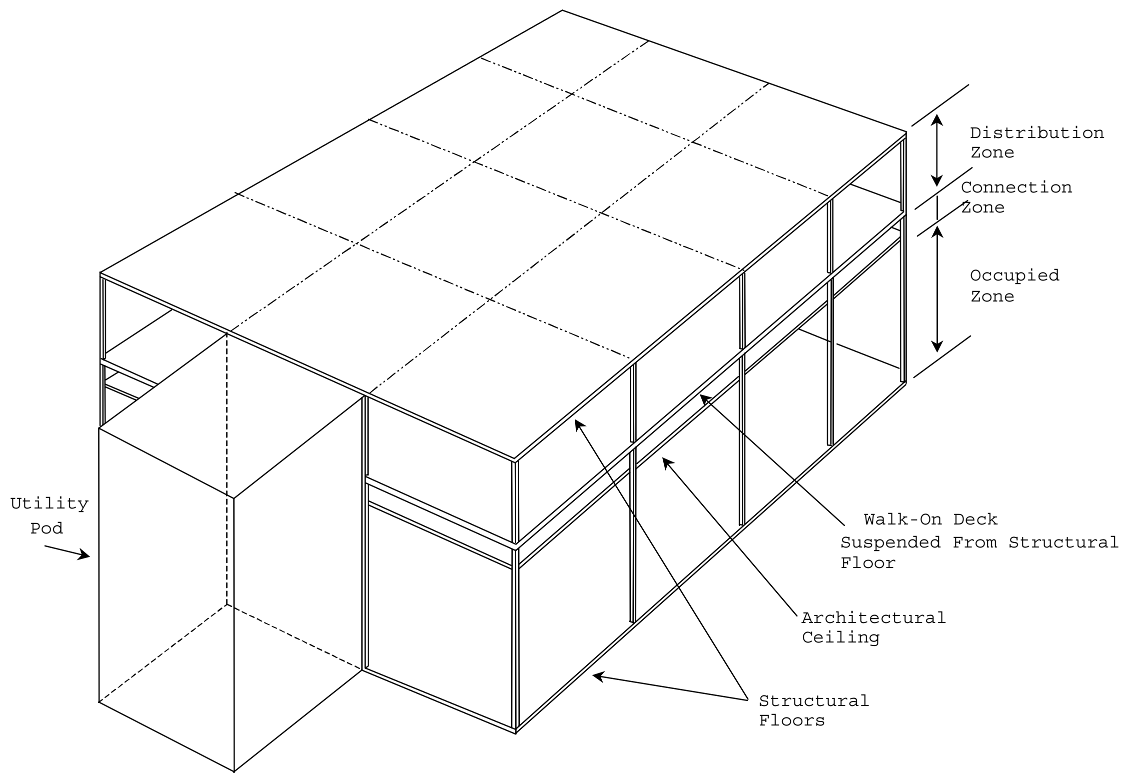
19.4.1.3 Connection Zone. The connection zone is the layer of space between the underside of the walk-on deck of the distribution zone and the architectural ceiling of the occupied zone below. The connection zone accommodates the horizontal distribution of utilities to individual rooms. It shall be deep enough to accommodate recessed lighting fixtures and air diffusers and their supports. Access to the connection zone shall be from the occupied zone usually through the architectural ceiling.

19.4.1.4 Occupied Zone. The occupied zone is the zone of functional activity in a Systems Module. The occupied zone is defined by the floor and the architectural ceiling above.

19.4.2 Systems Module General Considerations.

19.4.2.1 Design Exceptions. Certain spaces within a building may not lend themselves practically or economically to the use of walk-on decks. Examples are sloped floor areas; high ceiling rooms such as operating rooms, auditoriums, warehouses and atriums; and MRI suites where equipment weight or unusual structural requirements may be applicable. These exceptions should be established early in the design process so that the IBS Systems Module design concepts can be modified for such spaces.

19.4.2.2 Building Expansion. The Government shall inform the designers at the beginning of the design process of any vertical or horizontal building expansion requirements, and to what extent planning, structure and utility systems must provide for these requirements. Placement of utility pods should not encumber building expansion.



TYPICAL SYSTEMS MODULE

FIGURE 19-1

19.4.2.3 Existing Buildings. When a Systems Module building is to be connected to an existing conventional building, design concerns may arise. Existing floor-to-floor heights are typically less than the heights required for Systems Module construction. Therefore, it will be necessary to determine which new floors should align with existing floors. Continuity with existing buildings should not be hastily assumed to preclude application of the IBS Systems Module design concepts.

19.4.2.4 System and Equipment Capacity Increases. The designers should recommend which utility systems should be oversized to accommodate future change. Air handling units in utility pods and ducts in distribution zones may be designed to have their capacities increased for future demand growth. Other distribution systems may also be designed to accommodate a degree of capacity increase. During initial design, the Government and the designers shall jointly determine the extent of system and equipment capacity increases required.

19.4.2.5 Distribution Zone Accessibility. The available vertical space clearances within the distribution zone shall be sufficient to permit the organization of the utility distribution systems for easy accessibility. It may not be practicable to arrange the distribution zone for complete accessibility to every component. However, it is important to examine the various accessibility requirements in order to best locate access aisles for primary accessibility to all main systems, feeders, connections and maintainable equipment.

19.4.3 Systems Module Mechanical and Plumbing Considerations.

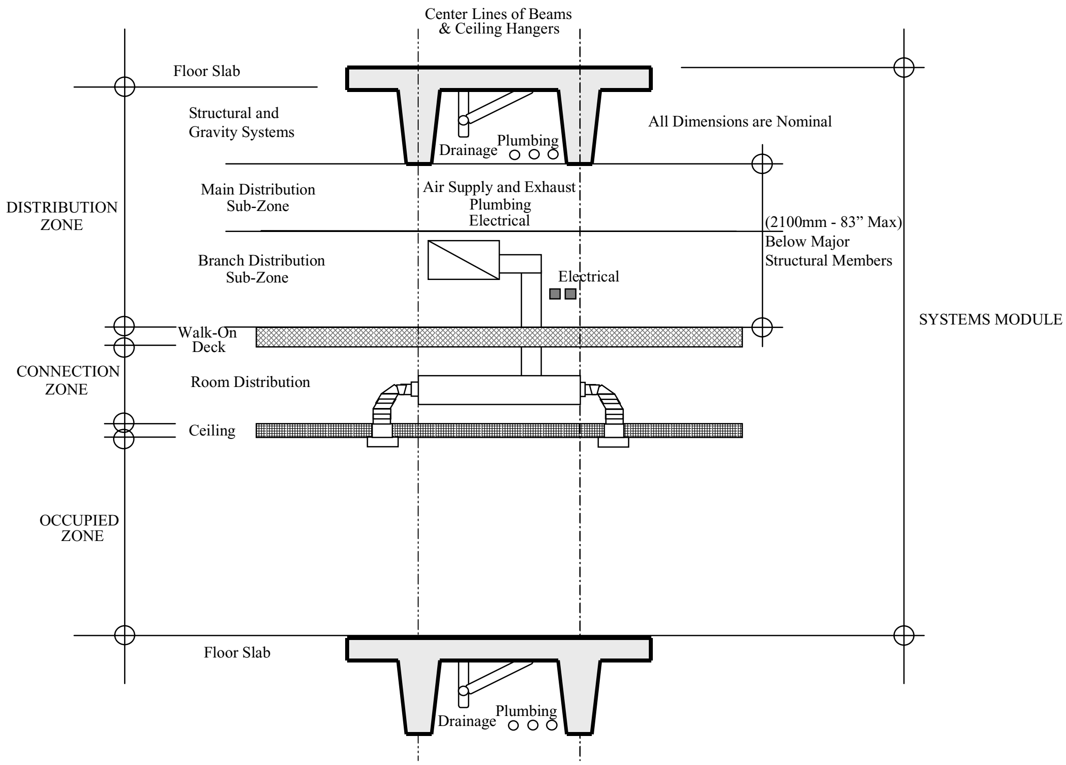
19.4.3.1 Riser Locations. Risers and vertical circulation elements, not located in the utility pods, shall be located at the boundaries of the Systems Modules adjacent to permanent structural elements, stairs or elevators.

19.4.3.2 Valves. Control valves, except those required to be in the occupied zone such as medical gas control valves, should be located in the utility pod to permit centralized control. Shutoff valves located in the distribution zone should be tagged and identified on a valve list that shows their distribution zone locations and the areas or equipment served in the occupied zone.

19.4.3.3 Systems Expandability. Prime moving equipment, i.e., pumps, fans, etc., shall be selected with conservative judgment and the distribution systems sized for expansion capability. In general, air handling units and pumps should be selected for operation at the midpoint of their operating characteristic curves. Ducts and piping should be sized to permit future flow increases. Stubs, valves and caps shall be provided in plumbing risers and in horizontal branch terminations for future service extensions.

19.4.3.4 Air Handling System Selection. System selection shall be based on functional needs, life cycle cost analyses, energy efficiency and ease of maintenance and repair. To enhance maintainability, it is normally desirable to "standardize" the size of air handling units when practicable from a performance standpoint. For example, several air handling units of the same unit size and motor horsepower, i.e., a modular design, will allow economy in the stocking of spare parts. "Off-the-shelf" packaged air handling units should be selected in lieu of custom manufactured units to assure parts availability and ease of future modification.

19.4.3.5 Ventilation of Distribution Zone. Under normal conditions, the distribution zone will not require fresh air ventilation. However, if so determined by the designers, ventilation may be required for moisture or temperature control in distribution zones exposed to roofs. A means of purging the distribution zone of smoke and other products of combustion shall be provided.



SYSTEMS MODULE ELEMENTS

FIGURE 19-2

19.4.3.6 Gravity Systems. The vertical depth requirement of sloped gravity piping services should be checked to determine if such piping will drop into the next lower distribution sub-zone or if an intermediate riser should be provided.

19.4.4 Systems Module Electrical and Communications Considerations.

19.4.4.1 Distribution Systems. Distribution system routing (horizontal and vertical), and the quantity and location of unit substations, shall be based on the size of the facility, life cycle cost analyses, overall flexibility, and long-term system reliability. The benefits of underground utility service distribution to the utility pods should be compared with service distribution through the distribution zones considering flexibility, reliability and safety.

19.4.4.2 Electrical and Communications Room Locations. Electrical and communications rooms shall be located in the utility pods and should be stacked vertically from floor to floor. Provisions should be made for easily running vertical cabling from floor to floor, i.e., conduit risers with pull boxes at each distribution zone. Cabling and wiring shall be sized for allowable voltage drop at full design load. For very long Systems Modules, the need for additional electrical and communications rooms, located at opposite ends of the Systems Modules from the utility pods, should be evaluated for maintenance of acceptable voltage drops, reasonable lengths of secondary cable runs, and numbers of devices per circuit. These additional rooms shall be located in the occupied zones adjacent to permanent structural elements, stairs or elevators and should also be stacked vertically from floor to floor.

19.4.4.3 Capacities for Flexibility. Capacities of major electrical components such as main distribution panels and transformers shall be based on the areas served, rather than specific use, to allow for flexibility. Communications systems shall be designed in a similar manner.

19.4.4.4 Electrical Secondary Distribution. Branch circuiting should be routed through the distribution zone to allow for modification with minimal disruption of the occupied zone. Cable trays shall be used to distribute electrical systems wiring. Ground continuity shall be provided throughout the cable tray system. Cable trays shall be designed using conservative judgment and space shall be dedicated in the distribution channels assigned to electrical services for future cable trays. See Section 13: Fire Protection for plenum rated cable requirements.

19.4.4.5 Communications Systems Distribution. Cable trays shall be used to distribute communications systems wiring. Ground continuity shall be provided throughout the cable tray system. Cable trays shall be designed using conservative judgment and space shall be dedicated in the distribution channels assigned to communications services for future cable trays. See Section 13: Fire Protection for plenum rated cable requirements.

19.4.4.6 Identification. Coded identification of electrical conduit runs by voltage and function shall be provided. Circuit identification for electrical wiring and system identification for communications wiring shall also be provided.

19.4.4.7 Lighting. Fifty lux (five foot-candles) of lighting shall be provided throughout the distribution zone. One hundred fifty lux (fifteen foot-candles) shall be provided over access aisles, using damage-resistant lighting fixtures. Egress lighting and exit signs shall also be provided over access aisles and at distribution zone exits. Switches shall be provided at each distribution zone entry and exit. Providing all switches with timers to turn off distribution zone lighting after a certain time interval should be considered.

19.4.4.8 Power. A pattern of electrical outlets shall be provided in the distribution zone for portable tools and extension cords.

19.4.4.9 Telephones. A pattern of telephone outlets shall be provided in the distribution zone for portable telephones. Telephone outlets located adjacent to maintainable equipment should be considered.

19.4.5 Systems Module Fire Protection Requirements. Refer to Section 13: Fire Protection for fire protection requirements.

19.4.6 Systems Module Construction Time and Cost Considerations.

19.4.6.1 Construction Time. Construction time for a Systems Module building can be less than for a conventional building. With a walk-on deck, trades can work concurrently in the occupied zone and the distribution zone rather than in sequence as in a conventional building. The majority of the work in the distribution zone can be performed in a comfortable standing position on the walk-on deck instead of from a ladder as in a conventional building. Repetition by modular design and standardization of equipment can also reduce construction time.

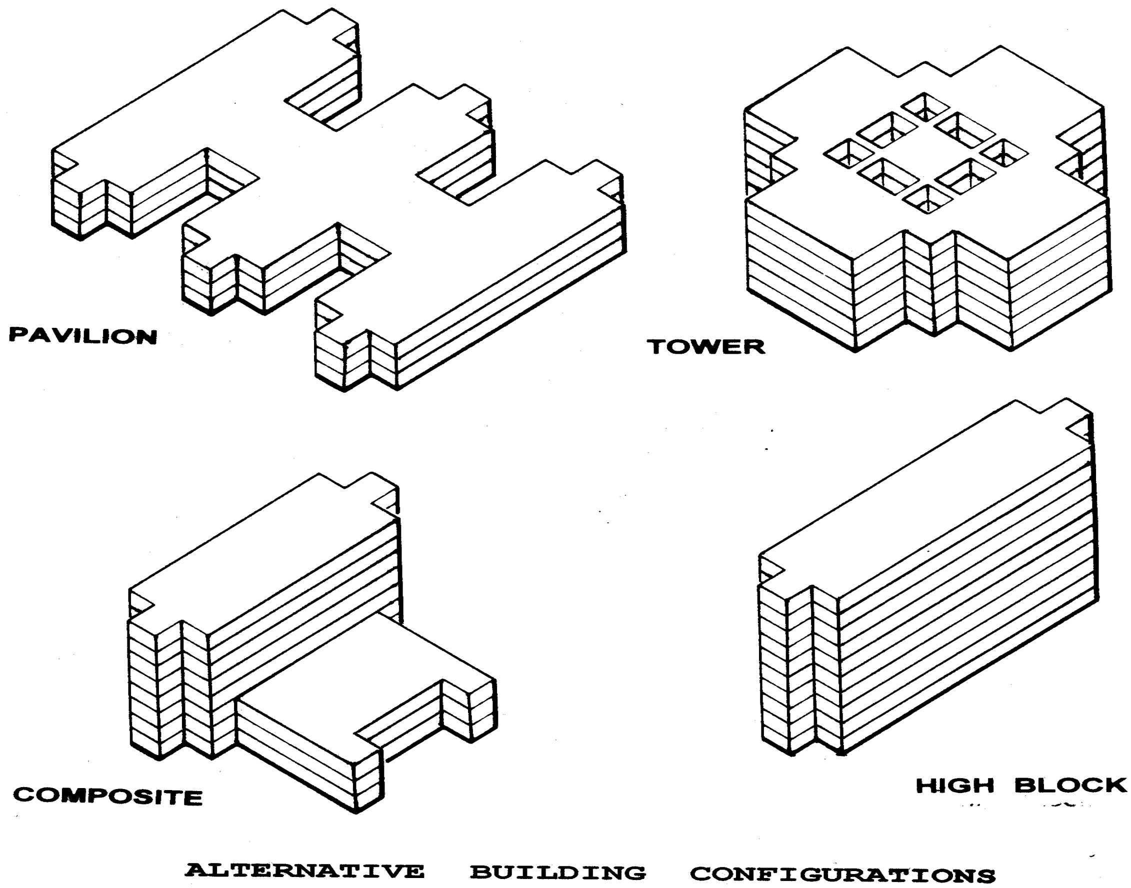


FIGURE 19-3

19.4.6.2 Construction Cost. The initial construction cost for a Systems Module building can be greater than for a conventional building due to the interstitial walk-on decks and increased building height.

19.4.6.3 Maintenance Cost. The maintenance cost for a Systems Module building can be lower than for a conventional building when accessibility to utility systems in the distribution zone is assured by observance of the IBS Systems Module design concepts presented in this section. Equipment is more easily accessed and workers are provided with convenient power, communications and lighting to facilitate maintenance tasks. However, there will be some added maintenance cost for the distribution zone, i.e., lighting, walk-on deck and access aisle repair, fireproofing repair or replacement, etc.

19.4.6.4 Flexibility for Modification and Alteration. Most medical and medical research facilities undergo frequent and significant modification and alteration during their lifetimes. In a conventional building, such changes normally result in extensive utility disruption for other areas due to the need to upgrade or modify systems. Typically, a Systems Module building modification requires only changes to distribution zone utility systems and equipment serving the portion of the occupied zone undergoing change, resulting in a simplified work effort and less disruption to the ongoing building function. Systems Module buildings inherently provide capacity for future expansion, load growth and modification, often without requiring costly primary and distribution equipment upgrades.

19.4.7 Systems Module Documentation and Construction Considerations.

19.4.7.1 Construction Documentation. Drawings for Systems Module buildings shall include plans and sections delineating utility distribution channels in each distribution zone sub-zone. Drawings shall be coordinated with all disciplines. Interdisciplinary cross-sections at critical locations, i.e., above operating rooms, equipment rooms, corridors, etc., shall be provided. Requirements for coordination of all disciplines prior to construction shall be included in all pertinent specification sections.

19.4.7.2 Pre-Bid Conferences. To ensure that construction contractors take the IBS Systems Module design concepts into account when preparing bids, presentations of these concepts are recommended for pre-bid conferences conducted by the Government.

19.4.7.3 Pre-Construction Consideration. For a Systems Module construction project, a sample distribution zone, at least 93 m^2 (1000 ft^2) in area, should be constructed at the project site. The sample should include a complete walk-on deck assembly with suspension members. The sample should also include elements of the utility systems within the distribution zone. Construction of the sample should be sufficiently in advance of building construction to allow time for necessary testing and approval. Various construction details can also be addressed and finalized with this sample, i.e., temporary protection of the walk-on deck during construction, proper support and sealing of ducts and fire dampers at walk-on deck penetrations, and permanent fire sealing of the walk-on deck to abutting walls and other permanent structural elements.